jacket has been decreased as might be expected; but this decrease is quite irregular, reaching a maximum of 0.064 inch about two feet from the upper, or muzzle, end of the jacket, while at the other end of the jacket it is 0.017 inch. The diminution of bore extends to the extremity of the breech beyond the region of compression due to the jacket.

The only hypothesis upon which these irregularities can be even tentatively explained is lack of homogeneity in open-hearth steel. The better the steel the more nearly perfectly does it recover from strain after the removal of stress. Irregularity in heating during the first attempt would have produced warping in any metal whatever. Perfectly homogeneous steel would have recovered completely when the temperature became uniform, but any lack of homogeneity implies a permanent set. Assuming such lack, the larger the scale of experiment the more difficult it is to secure uniformity of temperature. The steel may satisfy completely the demands of preliminary test experiments on elastic limit and tensile strength, yet it may fail to meet the requirements of accurate fitting and complete recovery after wide variation of temperature. Krupp, with his admirably homogeneous but high priced crucible steel, has already been successful in assembling the parts of guns twice as massive as the recent subject of experiment at Watervliet. It remains to be seen whether equal success will be possible by the use of open-hearth steel in connection with the 16-inch gun yet to be constructed. In the light of recent difficulties the approaching work will be watched with interest.

The publication of these observations in the present form would not have been possible but for the friendly courtesy of Major Isaac Arnold, Jr., the commandant of the Watervliet Arsenal, who has granted me the utmost freedom of access to the gun shops and who kindly invited my interest and cooperation in the attempt to solve the problem of the unmanageable jacket.

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ONTOGENIC AND PHYLOGENIC VARIATION.

In an article published in 1894, in Merckel u. Bonnet's *Ergebnisse der Anatomie u. Entwicklungsgeschichte*, the writer proposed the distinction which forms the title of this article. This subject was further elaborated in three papers before the Biological Section of the New York Academy, in March, April and May, 1896. As Prof. C. Lloyd Morgan and Prof. J. Mark Baldwin have quite independently reached somewhat similar conclusions, it seems of interest to publish the second and third papers, above referred to, in their original form as they were mailed to the Secretary of the Academy. These papers, by an unfortunate oversight, were never sent to the printers. The first paper was published in the *Transactions* and abstracted in Science.

The title of the paper of April 13th was 'A Mode of Evolution requiring neither Natural Selection nor the Inheritance of Acquired Characters.' It was discussed by Prof. Baldwin and Prof. Cattell. "I present a continuation of the subject of Ontogenic and Phylogenic Variation, discussed at the last meeting of the Biological Section. The latest papers upon selection are significant because they show that the hypothesis of evolution purely by the selection of fortuitous variations is losing ground. Definite or determinate variation is now admitted by nearly all writers except Wallace. If we assume the transmission of acquired characters the explanation of definite variation becomes simple enough, but in this contribution I propose a view of the facts which does not assume the transmission of acquired characters nor the im-

mediate action of natural selection. It is thus a phase of evolution without either natural selection or the transmission of acquired characters. I have no new facts to bring forward, but wish to present certain well-known facts in a new aspect which has a very direct bearing upon the theories of Spencer and Cope, as well as of Weismann. The recent papers of James Mark Baldwin contain something very similar under the term Social Heredity. It involves what the botanist, George Henslow, has been calling 'Self-adaptation.' In personal conversation Lloyd Morgan has recently expressed to me very similar views.*

The matter rests upon well-known biological principles which may be expressed in the following formula:

$$\left(\begin{array}{c}\text{Adult Organism.}\end{array}\right) = \left(\begin{array}{c}\text{Congenital, Constitutional or Stirp.}\end{array}\right) \times \left(\begin{array}{c}\text{Conditions of Environment throughout whole Period of Development.}\end{array}\right)$$

Every adult organism, therefore, has a single set of characters, but each of these characters has a double origin due to the adjustments and readjustments of its internal and external relations in course of growth. To sharply distinguish these two origins, I some time ago proposed the terms phylogenic and ontogenic, as in the following table:

VARIATIONS.

ONTOGENIC.	PHYLOGENIC.
Arising in course of development from chemico-physical, motor, psychical (social and imitative) causes.	Variations within the phylum, part of which were originally ontogenic.

Thus the really superficial or transient differences between organisms are upon the ontogenic side. The fundamental differences are phylogenic. The importance of the discrimination between these origins becomes apparent only when we realize what profound modification occurs in the course of ontogeny and how very generally these modifications are confused with those which really belong within the phylum.

When we fully grasp the possibilities of ontogenic variation it appears that ontogenic evolution must be a leading, progressive, guiding process, and is so far in advance of phylogenic evolution that in many cases it gives rise to characters which we use to separate species and even genera. There is thus an individual evolution which progresses under the following well-known laws: (1) When the environment changes, the adult individual changes, without necessarily involving any alteration of the stirp. (2) These ontogenic changes may be progressive or retrogressive, and reach a term which we would give specific or generic rank, as in the transformation of *Artemia* or *Saturnia*. (3) A limited, if not complete, *internal adaptation* must occur, because the growth of every part of the organism depends upon the nutritive materials supplied to it as well as upon the stimuli which the environment arouses. As shown in experimental embryology, a series of readjustments of an adaptive character always occur if the stimulus is not too profound. (4) As to the external adaptation of the organism to its surroundings in the struggle for existence, it is apparent that chemical and physical changes do not *necessarily* fit the organism. (5) Yet such purely physical changes may be followed by associated adaptations. Thus an animal shut off from the action of light exhibits ontogenic degeneration of pigment and of vision, and, in general, of all organs which represent a response to light. This degeneration is compensated by an increased sensitiveness of the other sense organs of smell, touch and hearing. (6) The most definite adaptations arise as a result of new habits, motions, etc.

This principle of the ontogenic adaptive influence of habit is so well known, it is surprising that more allowance for

*See SCIENCE, Nov. 20th.

it has not been made in the study of adult characteristics. In the anatomy of the different races of man, for example, it is demonstrated that many features are fundamental race characters, while others are merely the expression of certain habits, such as modes of walking, climbing, squatting, etc. The studies of Lane upon the anatomy of laboring men of different trades prove that entirely new structures, such as articulations and facets, may be developed. This has an important bearing upon the scope of the 'predisposition' principle. New facets do not arise because there is a predisposition at a certain point to form a facet, but because the local tissue reactions at that point under stimulus result in a facet.

Such ontogenic variations may extend over an enormously long period of time, and it is very obvious that they anticipate the future course of evolution, so far, at least, as all parts of the body are concerned which are directly modified by stimuli. Thus, whether these ontogenic variations are inherited or not, they predetermine the course of evolution. They set a groove, as it were, along which evolution must take its course.

These variations, further, are of so perfect a character that they have been by nearly all observers misinterpreted. They have been wrongly considered as representing phylogenic evolution, but such evolution is a matter of constitutional or stirp variation, as shown by the well-known examples of the pigmentation of the lower side of the flounder and of the entire body of the colorless Proteus when exposed to light. If these animals are contrasted with an albino type, such as the albino breed of Amblystoma, the real difference becomes apparent.

Thus the case appears to be established that ontogenic evolution parallels, and in many parts of the body anticipates, phylogenic evolution by enormously long periods of time. We have in these facts a partial explanation, at least, of *determinate variation*. The straight lines which certain characters follow are simply guided by ontogeny. In many structures the inherent adaptive power of the organism is so great that it can conform sufficiently to its new environment without any change in the stirp.

Two questions remain: (1) whether such evolution is accumulative; (2) what relation it bears to phylogenic evolution. These will be discussed at the next meeting of the Section."

This meeting was held upon May 8th.

"Continuing the subject discussed at the last two meetings, it has been questioned whether this ontogenic evolution can properly be considered evolution at all. It appears, so far as all those characters are concerned which are adaptively plastic, that the first stages of their true evolution must be ontogenic. Subsequently, the same changes become phylogenic, but the passage from one to the other is so gradual and insensible that they must all be considered part of the same process. Ontogenic evolution, then, represents the extreme changes in organisms possible during individual development; changes in color, hair texture, plumage, scales, and the greater or less ossification of the skeleton; in the forms of the joints and articular surfaces; in the development of the nervous centers and the muscular system; in short, every change which does not involve a change of stirp.

The chief question remains whether such evolution is accumulative. It is obviously accumulative if the change of environment becomes more intense and so far as new habits in successive generations become accumulative by practice and imitation. In the case of plants exposed through several generations to the same environment there is observed a marked loss of *stability*; thus the ontogenic variations are more marked in each successive generation.

But certainly the crucial point is what

relation do these ontogenic changes bear to the stirp. It is demonstrated that characters of this class finally become hereditary, because we ultimately find them in the organism at a stage preceding either exposure to external conditions, use or exercise. It would appear extremely difficult to determine whether this inheritance is due to Lamarck's principle or to the gradual *selection* of congenital predispositions. In the latter case we have a valid explanation of orthogenic, determinate or definite variation, so far as a very large class of characters are concerned, for it is obvious that ontogenic evolution works on all individuals practically alike. It gives a definite trend to evolution and it does away with the selection of fortuitous variations. This, however, is not a complete explanation of definite variation, because we find the same definite principle operating in the evolution of the teeth, which are not, so far as we know, subject to ontogenic variation. The only explanation which we can offer of definite variation in the teeth is that all animals which arise from a similar stem form seem to have their new characters constitutionally predetermined. Thus each new character will arise at a certain point, and in nearly the same order in all animals which are derived from a similar stem. Thus we may say that adaptive evolution is not confined to organs in which individual reaction or ontogenic evolution is operative."*

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* Prof. Morgan has proposed the term 'Modification' for the change here defined as 'Ontogenetic Variation.' The term 'Phylogenic Variation' was first used by Nägeli; it is equivalent to the term 'Mutation' as employed by Wagner and Scott. Prof. Baldwin, in April, 1895, proposed the term 'Organic Selection' for the processes of ontogenic evolution substantially similar to those here described. As pointed out by Prof. Morgan in last week's SCIENCE, this principle was also clearly stated in Weismann's Romanes' Lecture. These matters will be discussed in a later number of SCIENCE.

CURRENT NOTES ON ANTHROPOLOGY.

THE PARIS SCHOOL OF ANTHROPOLOGY.

THE program of this school for 1896–7 has been issued. About two hours a day are devoted to lectures. They embrace the following topics:

1. Prehistoric Anthropology: Prof. A. de Mortillet on prehistoric times.

2. Pathological Anthropology: Prof. Capitan on disorders of nutrition in their influence on races, etc.

3. Ethnography and Linguistics: Prof. Lefèvre on the Middle Ages and times.

4. Ethnology: Prof. Hervé on the accessary ethnic elements of France.

5. Biological Anthropology: Prof. Laborde on the senses of sight and hearing in race studies.

6. Zoological Anthropology: Prof. Mahoudeau on heredity and transformation in relation to man.

7. Geographical Anthropology: Prof. Schrader on the relations of earth to man in Asia.

8. Physiological Anthropology: Prof. Manouvrier on the elements of character.

9. Sociology: Prof. Letourneau on certain features in the history of civilization.

10. Comparative Ethnography: Prof. A. de Mortillet on the worship of the dead and burial ceremonies among primitive peoples.

This program will give a good idea of the scope of instruction in this, the oldest school of anthropology. It is now in the twenty-first year of its existence.

AN ARCHÆOLOGICAL MAP OF OHIO.

THE Ohio State Archæological and Historical Society for the past three years has been hard at work upon a large map of the State, which is to show all the prehistoric monuments and sites, according to town-